PRELIMINARY REPORT ON OBSERVATIONS OF AIR CELLS IN SNOWFLAKES AND IN OTHER FORMS OF ICE

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[North Carolina State College, University of North Carolina, Raleigh, N. C., September 1937]

Examining snowflakes that were in the process of melting immediately after they had fallen, early in the spring of 1936, the writer observed that when the melting line through a snowflake reached one end of a long, regular air cell in the flake and punctured its wall, water ran up into the air cell for approximately 40 percent of its length. The facilities for observation during that snowfall were not very good, but the striking fact was noted that the air in all cells showed practically this same 40 percent contraction.

This phenomenon is of considerable physical interest, and also suggests a possibility of practical application. If the principal cause of the contraction of the air in the cells is the higher barometric pressure at the earth's surface, then from the standard hypsometric formula the height at which the snow was formed may be inferred; it was hoped that further investigation would indicate what corrections would have to be introduced for temperature change, vapor pressure, and capillarity.

No more snows in 1936, and only one in 1937, presented opportunity for further observations In the 1937 snow, consistent values of 36 percent were found for the contraction of the air in the cells. In the meantime, observations were begun on air cells in other forms of ice.

Air cells in the following three forms of ice have been examined: (1) Ice formed in variously shaped concrete vessels, (2) thin ice layers formed over puddles, (3) ice columns rising from the ground on cold nights.

Six massive cement blocks were cast, with cavities in the form of a circle, an ellipse, a square, a rectangle, a triangle, and a six-pointed star; six others were also cast with dimensions one-third those of the first six. Each of the cakes of ice slowly frozen in these cavities during cold nights formed characteristic patterns of long air cells throughout the volume. These patterns were suggestive of stress lines developed during freezing, and varied somewhat with the rate of freezing. Photographs were made of the patterns, but a more accurate control of freezing conditions is needed before results are reproducible. The air in these cells showed no contraction on melting.

Air cells in thin ice layers are likewise not observed to contract on melting, but the shapes these air cells take are found to be very characteristic. Instead of being straight and regular, they tend to bend at one or more points at an angle of approximately 120°. The natural assumption is that the air has been expelled to the edge of the ice crystal during freezing, and the 120° angles are found at the points where the air cells along two edges of a crystal meet. Observations under high magnification on the freezing of water at an interface with a mineral oil, showed the formation of ice under these conditions to be the result of a number of more or less distinct steps, and the formation of air cells was visibly associated with only the last of these steps. H. T. Barnes [1] has photographed one of the intermediate steps in the formation of ice on a free water surface; the winter's observations under the above conditions showed what Barnes called "colloidal ice" particles to be elongated rather than circular as shown in Barnes' photograph. These phenomena are to be further studied and photographed; they are mentioned to show that it is unsafe to assume too much simplicity in the manner in which air cells may be formed in ice.

The columns of ice often forced up from the ground on cold nights are found to be filled with many long, parallel air cells. Those observed were not as regular as the air cells in snow, and varied much more in diameter among contiguous parallel cells. When a line of melting punctures one end of one of these air cells, an air bubble immediately starts to form as though the pressure of the air within were slightly greater than that of the external atmosphere. Since the capillary pressure in the bubble must be less than that in the air cell, and grow still less as the bubble grows greater, the bubble naturally tends to grow larger. This causes a break in the air column about the middle of the length of the remaining air cell. The air bubble then separates from the air cell, and water runs up into the air cell half or more of its length. Thus the phenomena observed in air cells of melting frost columns are entirely different from those found in air cells of melting snowflakes; the former seem to have an excess air pressure, while the latter have a deficiency of pressure relative to the surrounding air.

The Weather Bureau has cooperated with the writer by arranging for observations of air cells in snowflakes at three Weather Bureau stations where the aid of university physics departments may be obtained. A few preliminary results that have been reported have corroborated the peculiar contraction of the air in the cells of snowflakes, and have given values between the 36 percent and 40 percent originally found. Means for artificially producing snow have also been devised for this study.

Correspondence and cooperation with the author on the part of any who may wish to observe air cells in snow or ice are invited.

[1] H. T. Barnes, *Ice Engineering*, p. 8.

FURTHER OBSERVATIONS ON THE NORTH AMERICAN HIGH-LEVEL ANTICYCLONE

By THOMAS R. REED

[Weather Bureau, San Francisco, Calif., July 1937]

Four years ago the author [1] drew attention to the existence in summer of a thermally-induced anticyclone in the upper air over the North American continent, and showed how it was related to certain aspects of weather in the western United States, such as the prevailing temperature inversion over the south Pacific Slope, the occurrence of "Sonora" and "Arizona" type rains in the Far Southwest, and the occasional prevalence of summer thundershowers in other parts of the normally dry Far West. The study was based on 3 years' collection of upper-wind statistics for the United States, and utilized resultant wind data for the 4,000 meter level as published in the MONTHLY WEATHER REVIEW for the years 1930, 1931, and 1932. The present study incorporates similar data which have

[1] Thomas R. Reed, "The North American High Level Anticyclone," MONTHLY WEATHER REVIEW, November 1933, vol. 61: 321-325.